

## SCANNING DEVICE AND METHOD FOR SAVING COMPENSATION MEMORY

### BACKGROUND OF THE INVENTION

#### 5 Field of Invention

[0001] The present invention relates to a scanning device and a scanning method. More particularly, the present invention relates to a scanning device and a scanning method capable of saving some compensation memory.

#### 10 Description of Related Art

[0002] Due to rapid development of multi-media systems, there is a demand for images with a higher resolution. To increase image resolution, the number of light-sensitive cells (such as charge coupled device (CCD)) in the sensing device of a scanner must increase correspondingly

15 [0003] Because of some intrinsic properties of a charge-coupled device (CCD) or manufacturing deviation, sensitivity of each CCD cell may not be identical. Hence, before scanning an object, the scanner must perform a light-intensity calibration to produce a set of shading values so that image compensation can be conducted subsequently. Any non-uniform light-intensity effects in the pixels generated by the  
20 CCD can be compensated for using the shading values. Ultimately, color of the pixel and the color on the target object are identical. To use the shading values in image compensation, the shading values need to be stored in compensation RAM units inside the scanning device. As resolution of a scanner increases, the number of pixels in a CCD increases correspondingly. Since a larger compensation memory must be used to store up

the shading values required to compensate the light-intensity of a scanned image, production cost of a scanner increases.

## SUMMARY OF THE INVENTION

5 [0004] Accordingly, one object of the present invention is to provide a device and a method of saving compensation memory for holding shading values in a scanner. The shading values are divided into odd shading values and even shading values. The odd and the even shading values are averaged to produce an odd-even shading value. Two consecutive sets of image pixels obtained through a charge-coupled device (CCD) use the  
10 same odd-even shading values for image compensation. With this arrangement, only half of the conventional compensation memory in a scanner is required.

[0005] To achieve these and other advantages and in accordance with the purpose of the invention, as embodied and broadly described herein, the invention provides a compensation memory saving scanning device. The device includes an input device, an  
15 application specific integrated circuit, a compensation memory unit, an image memory unit and an input/output interface. The application specific integrated circuit couples with the input device, the compensation memory unit, the image memory unit and the input/output interface.

[0006] Even data values and odd data values are input to the application specific  
20 integrated circuit via the input device. After performing a computation using the even data values, the odd data values and preset values, the application specific integrated circuit averages out the even compensation values and the odd compensation values to produce averaged odd-even compensation values. The averaged odd-even compensation

values are stored inside the compensation memory unit. Scanned pixel data are stored inside the image memory unit before outputting to the input/output interface.

[0007] This invention also provides a scanning method capable of saving some compensation memory. First, even compensation values necessary for compensating even-numbered pixels and odd compensation values necessary for compensating odd-numbered pixels are extracted. The even compensation values and the odd compensation values are averaged to produce averaged odd-even compensation values.

[0008] Compensation values necessary for compensating an image must be stored inside a compensation memory unit. To save some compensation memory space, odd compensation values and even compensation values are averaged to produce half as much even-odd compensation values so that only half of the memory is required to hold the data.

[0009] It is to be understood that both the foregoing general description and the following detailed description are exemplary, and are intended to provide further explanation of the invention as claimed.

#### BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings are included to provide a further understanding of the invention, and are incorporated in and constitute a part of this specification. The drawings illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention. In the drawings,

[0010] Fig. 1 is a block diagram showing a scanning device capable of saving compensation memory according to one preferred embodiment of this invention;

[0011] Fig. 2 is a schematic diagram of an alternative-sensing device for holding compensation data according to one preferred embodiment of this invention;

[0012] Fig. 3 is a schematic diagram of a linear-sensing device for holding compensation data according to one preferred embodiment of this invention; and

5 [0013] Fig. 4 is a flow diagram showing the scanning method for saving some compensation memory according to one preferred embodiment of this invention.

### DESCRIPTION OF THE PREFERRED EMBODIMENTS

10 [0014] Reference will now be made in detail to the present preferred embodiments of the invention, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers are used in the drawings and the description to refer to the same or like parts.

[0015] Fig. 1 is a block diagram showing a scanning device capable of saving compensation memory according to one preferred embodiment of this invention. As  
15 shown in Fig. 1, the scanning device includes an input device 10, an application specific integrated circuit 16, a compensation memory unit 18, an image memory unit 20 and an input/output interface 22. The input device further includes a sensing device 12 and an analogue/digital converter 14.

[0016] The sensing device 12 couples with the analogue/digital converter 14.  
20 The analogue/digital converter 14 couples with the application specific integrated circuit 16. The compensation unit 18, the image memory unit 20 and the input/output interface 22 all couples with the application specific integrated circuit 16.

[0017] Fig. 2 is a schematic diagram of an alternative-sensing device for holding compensation data according to one preferred embodiment of this invention. In this

embodiment, an alternative-sensing device is used as the sensing device 12. Before the scanning device scans an image object, a compensation procedure is performed. In general, white is used as a compensation color. When the scanning device is conducting a compensation procedure, CCD cells  $1x \sim Nx$  (Fig. 2) of the sensing device 12 will convert the sensed light intensity into respective currents and transfer to the storage electrodes for producing signal charges. The charges are then transformed to appropriate voltage differential. The alternative-sensing device uses such procedure to perform an alternate scanning of the compensation white so that a multiple of alternative scanning pixels are output to the analogue/digital converter 14. In addition, a linear sensing device similar to the one shown in Fig. 3 may also be used as the sensing device 12.

[0018] As the analogue/digital converter 14 receives the alternately scanned image pixels, alternate scanned pixels in an analogue format are digitized into even data values and odd data values. Thereafter, the even data values and the odd data values are transferred to the application specific integrated circuit 16.

[0019] The application specific integrated circuit 16 receives the even data values and the odd data values. After performing a computation using the even data values, the odd data values and preset values, the application specific integrated circuit 16 averages out the even compensation values and the odd compensation values to produce averaged odd-even compensation values. The averaged odd-even compensation values are stored inside the compensation memory unit 18. For example, when one of the even  $2x$  CCD cells and one of the odd  $1x$  CCD cells scan an image pixel, optical data are converted into an even data value = 250 and an odd data value = 262 via the analogue/digital converter. The application specific integrated circuit 16 receives both the even data value and the odd data value. Inside the application specific integrated circuit 15, a preset value = 255

is subtracted from the even value data = 250 to produce an even compensation value = -

5. Similarly, a preset value = 255 is subtracted from the odd value data = 262 to produce

an odd compensation value = 7. Thereafter, the even compensation value and the odd

compensation value are averaged ((even compensation value = -5 + odd compensation

5 value = 7)/2) to produce an averaged odd-even compensation value = 1. Finally, the

averaged odd-even compensation value is transferred to the compensation memory unit

18. In this embodiment, compensation white is used as color compensation. Hence, the

preset value is 255.

[0020] After performing the compensation procedure, the scanning device starts

10 to scan an object document. The even 2x CCD cells and the odd 1x CCD cells scan image

pixels and the optical data are converted into even data values and odd data values by the

analogue/digital converter 14. The resultant data values are transferred to the application

specific integrated circuit 16. At this stage, the averaged odd-even compensation value =

1 is retrieved from the compensation memory unit 18. After adding the averaged odd-

15 even compensation value to the even data value and the odd data value, a pair of image

values is output to the image memory unit 20. The odd and even image values reside in

the image memory unit 20 until they are required by the input/output interface 22. When

such moment arrives, the application specific integrated circuit 16 reads out the pair of

image values from the image memory unit 20 and sends them to the input/output interface

20 22.

[0021] According to the flow described in Fig. 1, a flow diagram showing the

scanning method for saving some compensation memory is produced in Fig. 4. As shown

in Fig. 4, step S400 is executed to provide an even compensation value and an odd

compensation value. Step S402 is executed to average out the even compensation value

and the odd compensation value and produce an averaged odd-even compensation value. Finally, step S404 is executed using the averaged odd-even compensation value to compensate for the values obtained from even pixel position and odd pixel position during a scanning operation.

5 [0022] In this invention, compensation values are split up into odd compensation values and even compensation values. The odd and even compensation values are then averaged to produce an averaged odd-even compensation value. Since a pair of CCD cells uses the same odd-even compensation value after each scanning operation, memory capacity required for compensation data storage is cut in half.

10 [0023] It will be apparent to those skilled in the art that various modifications and variations can be made to the structure of the present invention without departing from the scope or spirit of the invention. In view of the foregoing, it is intended that the present invention cover modifications and variations of this invention provided they fall within the scope of the following claims and their equivalents.